TERRA Transportation Engineering and Road Research Alliance
Partnering for Roadway Innovation
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# New Approach Helps Maximize Saw-Cutting Times

Saw cutting plays an important role in concrete pavement projects. Knowing when a concrete mixture reaches initial set allows contractors to start pavement finishing and sawing activities at the earliest possible point. Late sawing can result in a high risk of random cracking. Sawing too early can cause raveling.

Often, the saw operator decides to saw freshly placed concrete slabs based on experience, but a more rigorous approach can offer greater precision in the decision, reducing debates and the possibility of error.

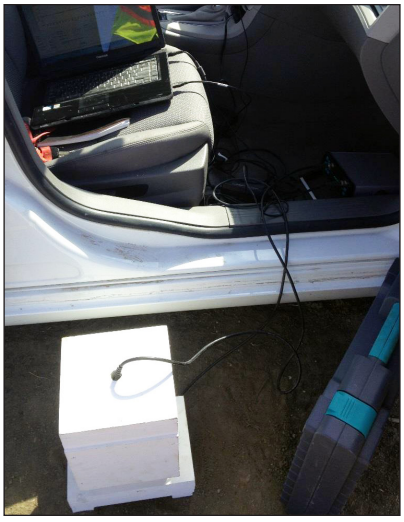
Recent research in the lab and the field points to the viability of a new approach that involves the use of ultrasonic pulse velocity (UPV) to increase accuracy in determining the optimal time for early entry saw cutting.

*Use of early entry saws*

## Overview

Iowa served as lead state on a Federal Highway Administration (FHWA) pooled-fund study to look at aspects of concrete pavement mixture design and analysis. Other partner states in the study included Colorado, Kansas, Michigan, Missouri, New York, Oklahoma, Texas, and Wisconsin.

As part of the work, researchers at the Iowa State University National Concrete Pavement Technology Center (CP Tech Center) explored the effectiveness of the UPV approach in measuring initial set time, both in the lab and in the field.



*Test setup with sample and transducers in a wooden frame for stability*

UPV works on a key principle: The speed of sound is lower in a fluid than in a solid. UPV equipment measures compression (p-waves that travel through the material) or shear waves (s-waves that travel at the interface between the material and its container or air). When the concrete mix starts to turn from fluid to solid, the time it takes for an impulse to travel through a sample will start to decrease. Previous work at Iowa State University clearly showed a good relationship between the time when the speed of sound accelerates in a sample and the initial set time.

## Benefits

Finding the optimal time to saw freshly placed concrete offers a number of advantages.

- Contractors can schedule crews when the work is ready to start, improving efficiency in operations and reducing the amount of overtime that occurs when crews must wait on site for sawing to start.
- The UPV approach involves equipment that is easy to use in the field.
- Monitoring the set time of a fresh mixture provides a tool to assess the uniformity between material and concrete batches.
- The UPV approach helps promote a greater understanding of concrete hydration, which helps in reducing construction repair costs.

*Crack at site 2 (one of eight construction sites in Iowa).*

## Project Results

This project built on earlier lab work that found a relationship between the measurement of speed of sound and initial set time. It focused on testing the UPV approach in the field on eight separate construction sites in Iowa. Testing occurred during a single summer–fall period on sites that used early entry sawing.

At each site, contractors continued to determine the initial set time in the manner of their choice and then reported the time when they sawed the corresponding portion of the slab.

At the same time, the testing involved obtaining a sample of concrete at the point of delivery and forming it into a 4" x 8" cylinder mold. The mold was placed into a frame with two transducers for use by the commercial p-wave device. During the test, the device was stored in or next to an open vehicle to maintain the test sample at the same temperature that the slab was experiencing. Researchers analyzed testing data and evaluated pavement conditions.

Based on the testing, UPV approaches appear to be able to report initial set times, and there also appears to be a good correlation between sawing and setting time. The data seem to indicate that after observing the initial set, early entry sawing should begin about 220 minutes later for the mixtures on the test sites.

## Next Steps

While the research explored the application of UPV to early entry sawing, the approach also offers potential applicability to conventional sawing methods as well. Researchers have begun to test UPV on field construction projects that use conventional sawing in Minnesota and Missouri, and plan to continue with at least five more projects in summer and fall 2015.

The CP Tech Center will continue to share results from field tests. The center plans to combine the application of UPV to both early entry and conventional sawing methods and develop a guidance manual for training and education. Findings will be presented at upcoming conferences, such as the 11th International Conference on Concrete Pavements in 2016 and the 2015 Mid-Continent Transportation Research Symposium, set for Aug. 19-20 in Ames, Iowa. A case-study journal paper also will be prepared as part of outreach to help share the application as a good quality-control method for departments of transportation and contractors.

## Resources

- *Comparison of Setting Time Measured Using Ultrasonic Wave Propagation with Saw-Cutting Times on Pavements in Iowa*
  (National Concrete Pavement Technology Center, Iowa State University Institute for Transportation, January 2014)

Links to these resources are on the TERRA website at TerraRoadAlliance.org.

### For More Information

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### About TERRA

The Transportation Engineering and Road Research Alliance, or TERRA, brings together government, industry, and academia in a dynamic partnership to advance innovations in road engineering and construction, including issues related to cold climates. More about TERRA is online at www.TerraRoadAlliance.org.

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